TITLE: REGULATORY ONLINE MANAGEMENT SYSTEM

INVENTOR: J. ROGER KELLEY

BACKGROUND OF INVENTION:

[0001] 1. FIELD OF INVENTION: The subject invention is generally related to automated methods for collecting data and generating reports relating to the data and is more specifically directed to a method for the on-line development and collection of data required to be submitted to regulatory agencies and the generation and submission of reports to such agencies

[0002] 2. DESCRIPTION OF THE PRIOR ART: It is widely recognized that most industries find themselves buried in a sea of regulatory compliance requirements. As industry is faced with this myriad of government regulatory requirements, the application and implementation has resulted in a significant impact to profitability. In response to this challenge, industry in general has been required to establish entire departments within their organizations in order to comply with these regulations, ranging in application from basic accounting and financial procedures to the very complex and costly environmental, industrial hygiene, and safety regulations. The staff required to deal with these government requirements include accountants, lawyers, medical doctors, engineers, chemists and other associated support staff.

[0003] As an example, there are over 8,000 producers of oil and gas in the United States, operating approximately 884,000 oil and gas wells. Each of these wells has its own specific and definite regulatory requirements. At present, the operator of each well must collect the critical information from each well, assimilate it into a data base and develop the required reports for each of the various regulatory agencies at both the state and national level. The task is expensive, time consuming and inefficient, at best.

[0004] There have been numerous attempts to automate this process. However, prior art system are not compatible with one another and, while each may be useful for a portion of the various required tasks there are not any systems that provide a comprehensive method for collecting, assimilating and storing data and generating therefrom the required reports for the various regulatory agencies.

SUMMARY OF INVENTION

[0005] The subject invention is directed to a method for collecting, assimilating and utilizing data from a variety of sources for determining the regulatory requirements and for generating the related compliance reports for an industry. In the preferred embodiment of the invention, the method comprises the steps of collecting external data for compliance requirements of a compliance model, collecting data from a user, assimilating the external data and the user data in a processor to determine compliance by the user, and automatically generating a report unique to the user data containing required compliance information.

[0006] One aspect of the subject invention is directed to an on-line accessible information management system designed to assist most industries in worldwide management of environmental, safety and regulatory compliance issues. It is intended to offer "one-stop shopping" for regulatory compliance and represents a substantial savings in costs and time over traditional means for complying with government regulatory reporting requirements. The subject invention is on-line and provides smart links to major information centers for any industry to provide easy access to relevant information. The system of the subject invention is designed to operate as an on-line consultant for assisting the user in determining the regulatory requirements of a relevant industry, providing the resources for complying with the requirements, preparing reports, and electronically submitting the reports to agencies having on-line reporting capability. The system is secure for each user, but will permit the sharing of public data in order to increase each user's data base. The system of the invention also includes a digital library providing each user with a full complement of regulatory information and research services. Specifically, the subject invention is directed to a convenient, cost effective method for assessing regulatory requirements, researching various databases to meet the requirements and preparing and submitting required reports. In a nutshell, the subject invention provides data collection, calculation, and reporting capabilities for environmental and regulatory compliance.

[0007] The subject invention is an on-line system designed to assist companies in managing their environmental, safety and regulatory compliance requirements. The system enables a user to assess the compliance requirements for a particular operation, and once the requirements are defined, permit the tools necessary to perform the appropriate regulatory compliance tasks. The information and tools consist of explanations of the regulations, text of regulations with appropriate annotations, information regarding forms, fees and penalties, and the like, agency

contacts and compliance procedures. The system is designed to perform the calculations required to complete the regulatory filings and then populate the reporting forms with specific results unique to the user.

[0008] As an example, an operator of an oil well will be required to determine the air compliance of a production compressor. Using the system of the subject invention, the operator will initially log on to the system to determine the related regulatory compliance requirements. He would access the "air module" of the system and enter his specific facility and equipment, i.e. location, equipment, specifications and the like. The system then provides the user with a list of applicable regulations for the compressor stations for that specific location and guides the user through the required steps for reporting the regulatory performance of the facility, including the automated processing of forms and reports, and in many cases the electronic submission of same.

[0009] Client data is collected from a variety of sources and location by a data collection module through a variety of means and is entered into the system database. A companion database, the system library, is maintained by an automated harvesting engine which updates the library with the latest statutory and regulatory information from all levels of government, as well as any forms or other necessary information. The system library is also populated with various constants and curves which are used in calculations.

[0010] The subject invention contains a number of calculation modules. Each calculation module is designed to take the appropriate client data stored in the system database and use that data as the input to a series of calculations that are necessary for the generation of various required reports. Each of these calculation modules may have one or more submodules and may generate several different outputs or reports. These reports are sent either electronically or on paper to the various agencies and departments that require them.

[0011] It is, therefore, an object and feature of the subject invention to provide a fully-integrated, on-line compliance system for regulated industries, including, but not limited to oil and gas, exploration and production, refining, manufacturing and retail in the energy and power exploration, development, production, and distribution industries, medical, banking and finance industries.

[0012] It is a further object and feature of the subject invention to provide a compliance system for regulated industries using a combination of full-featured, commerce-enabled, interactive web site along with offline data entry capability.

[0013] It is also an object and feature of the subject invention to provide method for collecting, assimilating, storing and distributing data required for regulatory compliance.

[0014] It is another object and feature of the subject invention to provide a method for generating reports required for regulatory compliance.

[0015] It is also an object and feature of the subject invention to provide a method for on-line, electronic submission of required regulatory compliance reports.

[0016] Other objects and features of the invention will be readily apparent from the accompanying drawing and detailed description of the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Figure 1 is a system overview.

[0018] Figure 2 shows detail of a sample air emission compliance module.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] The subject invention is directed to a system for collecting data from a plurality of public and private sources, merging the data to determine a regulation compliance model for the data, developing a compliance report for the data and electronically or manually submitting the report to the appropriate regulatory agency. An exemplary module is disclosed in detail herein for environmental compliance. The same methodology may be used for other regulatory compliance as well and the disclosure should not be considered as limited to environmental compliance schemes.

[0020] In the exemplary embodiment, the Data Collection Module (1.0) collects the data from the clients from a variety of sources and through a variety of means, and the data is then loaded into the System Database. The System Database stores all of the client data, organized by client, location, and equipment identifiers. The System Library contains two primary types of information. The first includes engineering constants and other constants and curves that are used in the various calculations. These are pre-loaded into the system and do not change. The second type of information is likely to change over time and is therefore constantly maintained and updated by an automated harvesting engine module (2.0) supplemented by human effort. This information includes the latest statutory and regulatory information from all levels of government, as well as any forms or other necessary information for environmental compliance

or reporting.

[0021] The Air Emission Compliance module (3.0) contains twelve (12) submodules. Eight (8) submodules obtain input data from the System Database and perform a variety of calculations. The remaining three (3) modules take the output from those modules and use them as inputs for generating reports. The submodules operate as follows:

[0022] 1. Tanks submodule (3.1)

This submodule calculates hydrocarbon emissions from the crude oil storage tanks according to EPA Document AP-42, *Compilation of Air Pollutant Emission Factors, Volume I, Supplement E: Stationary Point and Area Sources*, Chapter 12, Section 12.3-1 dated October 1992.

The primary calculation formulas are:

(3.1.1) $$L_T = L_S + L_W$$

(3.1.2) $$L_S = 365 V_V\, W_V\, K_E\, K_S$$

(3.1.3) $$V_V = \frac{\pi}{4} D^2 (H_S - H_L + H_{RO})$$

(3.1.4) $$W_V = \frac{M_V P_{VA}}{R T_{LA}}$$

(3.1.5) $$T_{LA} = .044 T_{AA} + 0.56 T_B + 0.0079 aI$$

(3.1.6) $$T_B = T_{AA} + 6a - 1$$

(3.1.7) $$K_E = \frac{dT_V}{T_{LA}} + \frac{dP_V - dP_B}{P_A - P_{VA}}$$

(3.1.8) $$dT_V = .072 dT_A + 0.028 I$$

(3.1.9) $$K_S = \frac{1}{1 + 0.053 P_{VA} H_{VO}}$$

(3.1.10) $$H_{VO} = H_S - H_L + H_{RO}$$

(3.1.11) $$L_W = 0.0010 M_V P_{VA} Q K_N K_P$$

Symbol	Name	Description	Type	Source
π	Pi	Constant dimensionless factor = 3.1415	Numeric	Mathematical constant (given)
a	Tank paint solar absorbence factor	Dimensionless empirical factor which has been established through experience.	Numeric	Reference from Table 12.3-7 in AP42 reference and based on color. Stored in System Library.
D	Tank diameter	Cross sectional linear measurement of the cylindrical tank. Units=linear	Numeric	Client data stored in System Database
H_L	Liquid Height	Average daily tank gauge reading which shows how much is in the tank. Units=linear (e.g. ft)	Numeric	Client data stored in System Database
H_{RO}	Roof Outage	Linear measurement of tank roof height measured from the vertical edge of the tank shell to the top of the dome or coned roof. Units = linear (l)	Numeric	Client data stored in System Database
H_S	Shell Height	Linear measurement of tank height excluding the height of the roof section of the tank. Units = linear (l)	Numeric	Client data stored in System Database
H_{VO}	Vapor Space Outage	The height of the inside tank space minus the liquid level in linear units, e.g. ft	Numeric	Result of Equation 3.1.10
I	Daily solar insolation factor	Empirical factor based on tank materials and conditions. Units = BTU / ft^3 - day	Numeric	Referenced from Table 12.3-6 in AP42 reference. Stored in System Library.
K_E	Vapor space expansion factor	Dimensionless empirical factor used to calculate standing losses in Equation (1)	Numeric	Result of Equation 3.1.7
K_N	Turnover factor	Dimensionless empirical factor	Numeric	Taken from Figure 12.3-6 in AP42 reference. Stored in System Library.
K_P	Working loss product factor	Dimensionless empirical factor which is product specific, i.e. 0.75 for crude oil and 1.0 for all other organic liquids.	Numeric	Included by reference. Stored in System Library.

Symbol	Name	Description	Type	Source
K_S	Vented Vapor Saturation Factor	Dimensionless factor used to calculate the Standing Storage Losses.	Numeric	Result of Equation 3.1.9
L_S	Standing Losses	Hydrocarbon air emissions from crude and condensate above ground storage tanks that are given off while the tank is standing idle (not filling and emptying) and contains some quantity of fluid. Measured in lbs/hr, lbs/day, and tons/year.	Numeric	Result of Equation 3.1.2
L_T	Total losses	Hydrocarbon air emissions from crude and condensate above ground storage tanks that are a sum of the working and standing losses as described above. Measured in lbs/hr, lbs/day, and tons/year.	Numeric	Result of Equation 3.1.1
L_W	Working Losses	Hydrocarbon air emissions from crude and condensate above ground storage tanks that are given off during operations (filling and emptying) and contains some quantity of fluid. Measured in lbs/hr, lbs/day, and tons/year.	Numeric	Result of Equation 3.1.11
Mv	Vapor Molecular Weight	Molecular weight or the weight of an Avogadro's number of molecules of the gases in the vapor space volume. Units = mass/mole (e.g. lb/lb mole)	Numeric	Taken from reference tables in the AP42 reference. Stored in System Library.
P_A	Atmospheric pressure	Standard ambient atmospheric pressure as measured via barometer, e.g. 14.7 psia	Numeric	Constant by reference. Stored in System Library.
dP_B	Breather vent pressure setting range.	The range in pressures at which the tank vent or hatch will relieve under the pressure of its contents.	Numeric	Client data stored in System Database. Otherwise the program will provide a default value if the user chooses.
dPv	Daily vapor pressure range	The range (or change) in the vapor pressure caused by the variance in maximum and minimum daily ambient temperatures. Provided by reference in pressure measurements.	Numeric	Derived from Figure 12.3-1 and Table 12.3-6 in AP42 reference. Stored in System Library.
P_{VA}	Vapor pressure	True vapor pressure of the liquid at the average liquid surface temperature. Units = force / unit area (f/l^2) (lbs/ inch^2)	Numeric	Vapor sample data stored in System Database or table in AP42 reference stored in System Library.

Symbol	Name	Description	Type	Source
Q	Annual net production through-put	The annual volume of hydrocarbons, e.g. crude oil, that is stored in the tank being considered. This figure is taken from actual lease production volumes. Volumetric units, e.g. bbls	Numeric	Client data stored in System Database
R	Ideal Gas Constant	Ideal gas constant calculated as (standard atmospheric pressure - ideal molar volume of gas / mole - standard temperature) (e.g. psia - ft^3 / lb-mole - °R (Rankine) = 10.731)	Numeric	Calculated from constants / Almost always used in USA as 10.731. Stored in System Library.
dT_A	Daily average temperature range (°R ,°K)	The difference between daily minimum and maximum temperatures taken from Table 12.3-6 as determined by regional location.	Numeric	Taken from Table 12.3-6 in AP42 reference. Stored in System Library.
T_{AA}	Daily average ambient temperature	Average of daily maximum and minimum ambient temperatures. Measured in °R or °K.	Numeric	Table 12.3 in AP42 reference. Stored in System Library.
T_B	Liquid bulk temperature	Liquid bulk temperature at standard temp Units = °R or °K	Numeric	Result of Equation 3.1.6
T_{LA}	Daily average liquid surface temperature	The average temperature measured at the surface of the liquid in the tank. In this case the temperature is calculated from ambient temperatures rather that measured. Units = °R(Rankine)	Numeric	Result of Equation 3.1.5
dTv	Daily vapor temperature range	The daily range in temperature of the vapor in the vapor space of the tank as described above; calculated.	Numeric	Result of Equation 3.1.8
Vv	Vapor space volume	Volumetric calculation of the average amount of space in the tank (overhead) that is not occupied by liquids. Measurement = l^3	Numeric	Result of Equation 3.1.3
Wv	Vapor density	Calculated density of the gases(vapors) in the vapor space calculated in equation (1)(a) Units= mass/unit volume (m/l^3) (e.g. lb/ft^3)	Numeric	Result of Equation 3.1.4

[0023] 2. Internal combustion submodule (3.2)

This submodule calculations emissions from internal combustion engines according to the method set forth in the AP42 *Volume I, Stationary Point and Area Sources*, Chapter 3, Section 3.2, U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. The emission factors used in these calculations are either provide by the manufacturer

for each particular engine or taken from the AP42 reference.

The primary calculation formula is:

$$(3.2.1)\quad \sum_{i=1 \text{ to } n} \frac{EF_i\ g}{1\ hp\ hr} \times \frac{\text{Rated } hp_i}{1} \times \frac{24 \text{ hrs}}{\text{day}} \times \frac{365 \text{ days}}{\text{year}} \times \frac{1 \text{ lb}}{453.6 \text{ g}} \times \frac{1 \text{ ton}}{2{,}000 \text{ lbs}} = \frac{\text{Emissions tons}}{\text{year}}$$

Symbol	Name	Description	Type	Source
EF	Emission Factor g/hp/hr	The amount of an individual pollutant that will be generated per horse power hour of operation, e.g. 2.0 grams NOx generated in grams per hp per hour.	Numeric	Provided by the user or obtained from the equipment data base by the id number or model of compressor
HP (hp)	Horse power rating	The power rating of the compressor in horse power per hour	Numeric	Provided by the user or obtained from the equipment data base by the id number or model of compressor

This formula is repeated for each piece of equipment using emissions factors for each of the following pollutants:

NOx	Nitrous Oxides	Nitrous oxide emissions	Calculated from AP-42 emission factors or manufacturers data.
CO	Carbon Monoxide	Carbon monoxide emissions	Calculated from AP-42 emission factors or manufacturers data.
SO_2	Sulfur dioxide	Sulfur dioxide emissions	Calculated from AP-42 emission factors or manufacturers data.
PA or PM_{10}	Particulates	Particulate emission from fuel combustion	Calculated from AP-42 emission factors or manufacturers data.
VOCnm	Non-methane Volatile Organic Compounds	Measurement of emissions of VOC's as tons per year.	AP-42 emission factors or manufacturers data.

[0024] 3. External combustion submodule (3.3)

This submodule calculations emissions of combustion gases from external combustion units based upon the normal gas consumption and factors for natural gas combustion found in AP-42 (10/92) Section 1.4, Tables 1.4-1 through 1.4-3. Combustion factors for commercial boilers are used in the calculations.

The primary calculation formula is:

$$(3.3.1) \quad \sum_{i=1 \text{ to } n} \frac{mmBTU_i}{hr} \times \frac{1\ SCF}{\text{Fuel Heat Value in } BTU} \times \frac{EF\ lbs}{mmSCF} \times \frac{24 \text{ hrs}}{\text{day}} \times \frac{365 \text{ days}}{\text{year}} \times \frac{1 \text{ ton}}{2{,}000 \text{ lbs}} = \frac{\text{Emissions tons}}{\text{year}}$$

Symbol	Name	Description	Type	Source
EF	Emission Factor lb / mmscf	Amount of pollutant species generated per unit of fuel used or burned, e.g. lbs (pounds) per mmscf (Million standard cubic feet) of gas burned.	Numeric	Client data stored in System Database
mmbtu	BTU rating of the unit	The size of the combustion unit as measured in BTU's per hour. mmbtu = million British Thermal Units	Numeric	Client data stored in System Database

This formula is repeated for each piece of equipment using emissions factors for each of the following pollutants:

NOx	Nitrous Oxides	Nitrous oxide emissions	Calculated from AP-42 emission factors or manufacturers data.
CO	Carbon Monoxide	Carbon monoxide emissions	Calculated from AP-42 emission factors or manufacturers data.
SO_2	Sulfur dioxide	Sulfur dioxide emissions	Calculated from AP-42 emission factors or manufacturers data.
PA or PM_{10}	Particulates	Particulate emission from fuel combustion	Calculated from AP-42 emission factors or manufacturers data.
VOCnm	Non-methane Volatile Organic Compounds	Measurement of emissions of VOC's as tons per year.	AP-42 emission factors or manufacturers data.

[0025] 4. Fugitive Emissions submodule (3.4)

Fugitive emission estimates for valves, flanges, piping and compressor seals in natural gas/vapor service are based on emission factors obtained from EPA Document EPA-450/3-83-007. For fugitive emission sources in crude oil service are based on SOCMI fugitive emissions (without ethylene) for components handling light liquids. VOC emissions from components in gas/vapor service are speciated based on gas analyses provided by the user. Emissions from components in crude oil service were not speciated because of the small quantity of emissions generated. Example calculations for fugitive emission estimates are

provided below. VOC estimates for fugitive emission sources in all services were derived by the following equation:

The primary calculation formula is:

$$(3.4.1) \qquad \sum_{i=1 \text{ to n}} \frac{EF_i\ lb}{hr_i} \times \frac{VOC\%_i}{1} \times \frac{24\text{ hrs}}{\text{day}} \times \frac{365\text{ days}}{\text{year}} \times \frac{1\text{ ton}}{2{,}000\text{ lbs}} = \frac{\text{Emissions tons}}{\text{year}}$$

This formula is repeated for each fitting in each piece of equipment.

Symbol	Name	Description	Type	Source
EF	Emission Factor	Amount of volatile organic emissions generated per fugitive component or source. E.G. lbs / hour / source	Numeric	Provided by reference from AP42 and SOCMI.
No. of components, (src)	Number of components	Actual number of each source component at the facility, e.g 355 valves, etc.	Numeric	Provided by the user or obtained from Client data stored in System Database or equipment data stored in System Library
VOC%	VOC Concentration in the affected stream	The concentration of VOC (volatile organic hydrocarbon compounds) defined as any compound with C3+ hydrocarbons as identified in the gas analysis and as calculated by volume %.	Numeric	Calculated from the gas analysis for this facility.

[0026] 5. Glycol Dehydration submodule (3.5)

Emissions for the glycol dehydration units were calculated using the GRI - GLYCALC model. All input variables are taken as provided by the client and are as follows:

Symbol	Name	Description	Type	Source
	Unit Description	Case name and case description used to retrieve case files from the GRI program. This name will also be identified by a facility ID number and an equipment ID number.	Text	Provided by the user or taken from the facility data base as a facility name.
	Annual Hours of Operation	Number of hours the unit operates annually, e.g 8760 hrs = 1 year	Numeric	Input by user or user data base.

Symbol	Name	Description	Type	Source
	Gas Composition	Percentages of all components in the gas stream. Individual values input separately from gas analysis.	Numeric and text	Gas analysis provided by user or from Client data stored in System Database
mmscf / day	Dry gas flow rate	The volumetric flow of the sales gas stream in volumetric units per day (e.g. mmscf/day or million standard cubic feet per day)	Numeric	Production data from user or Client data stored in System Database
lb / mmwscf	Dry gas water content	The target final concentration of water in the sales gas stream, in the USA the default value is 7.0 lb / mmscf	Numeric	Client data stored in System Database or accepted by default
	Absorber stages	Number of actual equilibrium stages in the contactor; may be chosen, if known, by the user as an alternative entry to the dry gas water content described above.	Numeric	Chosen by user
	Lean TEG/ EG flow rate	The pumping rate of the lean or fresh tri-ethylene glycol (or ethylene glycol) solution in gallons per minute	Numeric	Client data stored in System Database
	Water content	The allowable water concentration in the lean or fresh glycol stream. A default value of 1.5% may be chosen if the user does not have this value	Numeric	Client data stored in System Database or chosen by default
	Re-circulation ratio	The gallons of glycol solution circulated per pound of water removed from the wet gas stream if known. May be chosen in place of the lean TEG/EG flow rate. Default value of 0.3 may be chosen in the program.	Numeric	Client data stored in System Database
	Wet Gas Temperature	Temperature of the incoming wet gas stream in °F.	Numeric	Client data stored in System Database
	Wet gas pressure	Pressure of the incoming wet gas stream in psig.	Numeric	Client data stored in System Database
	Glycol pump type	May be gas driven or electric	Text	Client data stored in System Database
ACFM / gal	Gas driven pump volume ratio	ACFM (air cubic feet per minute) gas / gallon per minute glycol pumped (only for gas driven pumps) May choose default values of 0.03 for wet gas pressures greater than 40 psig and 0.08 for units with wet gas pressures less than 400 psig.	Numeric	Client data stored in System Database
	Flash Tank	Yes or no question. Is a flash tank involved with this unit.	Text	Client data stored in System Database

Symbol	Name	Description	Type	Source
	Flash tank temperature	Operating temperature of the flash tank if used in °Fahrenheit (°F)	Numeric	Client data stored in System Database
PSIG	Flash tank pressure	Operating pressure of the flash tank if used. Psig (pounds per square inch gauge)	Numeric	Client data stored in System Database
	Stripping gas option	Yes or no question. Is a gas stream used to remove the hydrocarbons from the glycol vent stream?	Text	Client data stored in System Database
	Stripping gas flow rate	Flow rate of the stripping gas stream, scfm	Numeric	Client data stored in System Database
	Control device option	Choose a control device as either a vent condenser or vapor incinerator, or choose no control device.	Text	Client data stored in System Database
	Vent condenser temperature	Operating temperature of the vent condenser (if used) in °F	Numeric	Client data stored in System Database
	Vent condenser pressure	Operating pressure of the vent condenser (if used) in absolute pressure, e.g. psia	Numeric	Client data stored in System Database
	Incinerator ambient air temperature	Average ambient air temperature for the location in °F	Numeric	Selected from climatic data stored in System Library
	Excess oxygen	% excess oxygen used in combustion process if a vapor incinerator is chosen as a control device.	Numeric	Provided by the manufacturer of the combustion unit and included in the System Library
	Combustion efficiency	% efficiency of the vapor control incinerator unit.	Numeric	Provided by the manufacturer of the combustion unit and included in the equipment data base.
VOCs	Volatile Organic Compounds	Measurement of emissions of VOC's as tons per year from the Glycalc Program Printout in tons/year	Numeric	Glycalc® program output
HAPs	Hazardous Air Pollutants	Volumetric measurement of a group of air constituents that have been determined by the Environmental Protection Agency (EPA) to be considered categorically hazardous to health and the human environment. Measured in tons/year	Numeric	Glycalc® program output or information gained from the EPA speciation program for HAP's.

[0027] 6. Flash Calculation submodule (3.6)

Two separate calculations are used to calculate the flash emissions caused by the transfer of higher pressure liquids from a process vessel to a storage tank of less pressure. These are the Black Oil GOR (gas oil ratio) method developed by Rollins, McCain and Creeger,

(3.6.1) $$\log R_{st} = 0.4896 - 4.916 \log \gamma_{ost} + 3.496 \log \gamma_{sp} + 1.501 \log P_{sp} - 0.9213 \log T_{sp}$$

and the Vasquez Beggs GOR Correlation.

(3.6.2) $$GOR = C1 \times SG100 \times (P_{str} + P_{atm})^{C2} \times e^{\frac{C3 \times {}^{\circ}API}{T_{gas}{}^{\circ}F + 460}}$$

(3.6.3) $$SG100 = SG \times (1.0 + 5.912 \times 10^{-5} \times T_{gas}{}^{\circ}F \times \log \frac{P_{sep} + P_{atm}}{114.7}$$

Symbol	Name	Description	Type	Source
R_{st}	Stock Tank Gas Oil Ratio (GOR)	The ratio of the volume of gas generated per barrel of oil produced as a result of the pressure drop between the pressurized separator and the oil storage (stock) tank. Units = volume gas / volume oil, e.g standard cubic feet / barrel	Numeric	Calculated by Black Oil GOR equation, 3.6.1
γ_{ost}	Stock Tank Oil specific gravity	Measurement of the ratio of the weight of the oil relative to water at standard temperature and pressure. E.g. units = lb/gal per lb/gal or SG=6.5 lb/gal oil / 8.34 lb/gal water @STP = 0.78	Numeric	Calculated using the physical data of the materials being stored
γ_{sp}	Separator specific gravity	Measurement of the ratio of the weight of the air relative to	Numeric	Calculated using the physical data of the gas being measured
P_{sp}	Separator pressure	The operating pressure of the vessel used to separate the oil, water and gas in the produced fluid stream	Numeric	Measured at the equipment by the user
T_{sp}	Separator temperature	The operating temperature of the separator measured in °F	Numeric	Provided by the user from field measurements
V_{MW}	Vapor Molecular Weight	The weight of one mole (or Avogadro's number of molecules) of the gas being measured.	Numeric	Determined by reference or measurement. May use default value or actual gas analysis.

Symbol	Name	Description	Type	Source
C1, C2, C3	Vasquez Beggs Constants	Constants calculated for the use in this relationship using statistical empirical data. Dimensionless	Numeric	Provided by reference to the relationship based on degree API gravity range of the crude being stored.
SG	Specific Gravity of the gas	Same as γ_{sp} or separator specific gravity as described above.	Numeric	Calculated using the physical data of the gas being measured
SG100	Specific gravity of the gas referenced to 100 psig	A calculated quantity based on the temperature and pressure measured at the separator referenced to 100 pounds per square inch gauge (psig) pressure.	Numeric	Result of equation 3.6.3
P_{str}	Pressure of the upstream fluid	Pressure of the fluid stream as it leaves the separator or the separator pressure.	Numeric	Measured in the field by the user.
P_{atm}	Atmospheric pressure	The measured pressure of ambient conditions or in the atmosphere outside the separator.	Numeric	Measured at the field location using a barometer or by default at ST&P.
T_{gas}	Gas temperature at the separator	The measured temperature of the gas stream in the separator	Numeric	Measured at the field location by the user.
P_{sep}	Separator Pressure	The operating pressure of the separator measured in psig	Numeric	Measured at the field location by the user.
psig	Pounds per square inch gauge	Pressure measurement in units of pounds per square inch or in general units - f/l^2.	Numeric	Measured with a pressure measuring device at the equipment site.
°API	Degrees API gravity	The measured API gravity of the fluid (crude) being measured as calculated by a standard equation which ratios the specific gravity of the fluid to a referenced standard.	Numeric	Calculated using the physical data of the fluid.
°F	Degrees Fahrenheit	The standard temperature measurement using degrees Fahrenheit as a scale.	Numeric	Standard unit
log	Logarithm	Mathematical relationship which equals the exponent value that the number 10 would be raised to get that same number.	Text	Standard unit

[0028] 7. Loading Losses submodule (3.7)

Loading losses are the primary source of emissions from rail tank car, tank car, and

marine vessel operations. Loading losses occur as organic vapors in "empty" cargo tanks are displaced to the atmosphere by the liquid being loaded into the tanks. These vapors are a composite of vapors formed in the empty tank by evaporation of residual product from the previous load, vapors transferred to the tank in vapor balance systems as product is being unloaded, and vapors generated in the tank as the new product is being loaded. Loading losses is calculated according to the procedures outlined in Section 5.2 of the EPA DOCUMENT AP-42, *COMPILATION OF AIR POLLUTANT EMISSION FACTORS, VOLUME I, STATIONARY POINT AND AREA SOURCES*, CHAPTER 5, SECTION 5.2 DATED JANUARY 1995. The quantity of evaporative losses from loading operations is a function of the following parameters:

- Physical and chemical characteristics of the previous cargo;
- Method of unloading the previous cargo;
- Operations to transport the empty carrier to a loading terminal;
- Method of loading the new cargo; and
- Physical and chemical characteristics of the new cargo.

Emissions from loading petroleum liquid can be estimated (with a probable error of 30%) using the following equation:

$$L_L = 12.46 \frac{SPM}{T} \qquad (3.7.1)$$

Symbol	Name	Description	Type	Source
L_L	Loading losses - VOC	The Volatile Organic Compound (VOC) emissions quantity as determined in the above equation.	Numeric	Result of equation 3.7.1
S	Saturation factor	Empirical quantity for calculation	Numeric	AP-42 reference Table 5.2-1. Stored in System Library.
P	True liquid vapor pressure of the liquid being loaded	The true vapor pressure of the liquid being loaded which is the pressure at which the liquid is in equilibrium with the overhead vapors. Measured in pounds per square inch atmospheric (psia)	Numeric	By reference from AP-42 Figures 7.1-5, 7.1-6, 7.1-2. Stored in System Library.

Symbol	Name	Description	Type	Source
M	Vapor Molecular Weight	The weight per mole of gases being emitted, e.g lb/lb mole. One mole = weight of 10^{23} molecules (Avogadro's number) of the gas or 359 standard cubic feet. (SCF)	Numeric	By reference from AP-42 Table 7.1-2. Stored in System Library.
T	Bulk Liquid Temperature	The temperature of the liquid being loaded in °R (Rankine) = °F +460.	Numeric	Supplied from the tank calculation data.

[0029] 8. **Hazardous Air Pollutants submodule (3.8)**

Hazardous Air Pollutants (HAPs) have been defined by the EPA to include the following compounds which are common to oil and gas production emissions:

- Hexane
- Xylene
- Benzene
- Xylene
- Toluene
- Ethylbenzene
- Formaldehyde
- Acetaldehyde

These component concentrations will be retrieved by using calculation routines that speciate the VOC emissions into the above compounds. Calculation routines such as this are produced in software form by both the Gas Research Institute and the Environmental Protection Agency. The user will need to only supply the equipment or application type and the VOC emissions for that particular unit and the program will speciate the HAP emissions form that stream by concentration and report them as such. The output for this module will be the HAP emissions in tons per year and lbs per day.

[0030] 9. Emissions Inventory submodule (3.20)

The air emissions inventory is a summary of all of the air emissions generated by the various unit sources at a facility. This inventory is a time based report that catalogues these emission volumes on an annual basis for reporting to the state air pollution control agencies. Each report must present:

1) The individual calculations for each unit source in the facility, which includes every piece of equipment or process that has the potential to produce air emissions of regulated constituents, e.g. nitrous oxides (NOx), carbon monoxide (CO), particulates (PA or PM_{10}), sulfur dioxide ($SO_{2)}$, volatile organic compounds (VOCs), hazardous air pollutants (HAPs), etc.

2) The sources of the data used in the calculations, i.e. measured data, estimated data, calculated data, industry or government standard data (AP42), etc., along with any assumptions associated with this data.

3) The summary of the emissions of the individual constituents reported by unit source and by facility.

4) The status of the equipment, e.g. active, idle, shut down, moved, etc.

5) All emissions factors used to calculate the emissions in the summary.

6) The operating schedule of each source or the amount of time (days, hours, etc.) that the individual sources were on line and operating (i.e. generating emissions) during the year.

7) The equipment parameters, i.e. stack height, stack diameter, power ratings (hp, btu, etc.), fuel usage, fuel type.

[0031] 10. Air Permitting submodule (3.21)

The air permitting data group will require much the same data as the emissions inventory group will, with much additional text type data required. In addition to the data listed in the table for each type facility and equipment, this group will include:

A) Company mailing and personnel information, e.g who will be the responsible party for signature authority on the permit, who will have regulatory responsibility over the compliance issues, and who will be responsible for operational oversight at this facility.

B) The legal location of the facility, e.g latitude / longitude, section-township-range, *utm* coordinates, etc., including county, state and nearest town or city.

C) The compliance codes for each unit at the facility, if a Title V Federal Operating Permit is being sought.

The permit will also required the same seven sets of information described above for submodule 3.21.

[0032] 11. Emissions Fees submodule (3.22)

The emissions fees submodule will take the summary emissions figures from the annual emissions inventory report and generate a figure for the fee based on these annual emissions. The sum total of these emissions will be multiplied by the price per ton per year for emissions fees that are established for that particular state. The user will be required to provide support for these figures in the form of sample calculations and equipment data verification sheets.

The primary calculation formula is:

(3.22.1) $$\sum \text{Emissions}\frac{\text{tons}}{\text{year}} \times \$ \text{ per ton} = \text{Annual Emissions Fee}$$

Symbol	Name	Description	Type	Source
$	Price per ton	The dollar price per tons of emissions as established by the particular state of operation	Numeric	Established by law
NOx	Nitrous Oxides	Nitrous oxide emissions	Numeric	Calculated
CO	Carbon Monoxide	Carbon monoxide emissions	Numeric	Calculated
SO_2	Sulfur dioxide	Sulfur dioxide emissions	Numeric	Calculated
PA or PM_{10}	Particulates	Particulate emission from fuel combustion	Numeric	Calculated
VOCs	Volatile Organic Compounds	VOC emissions	Numeric	Calculated

[0033] From the foregoing description of the preferred embodiment it will be readily understood that the subject invention provides a method for collecting, assimilating and storing data in a searchable database for providing automated on-line compliance with regulatory requirements of various agencies. While certain embodiments and features have been described in detail herein, it should be understood that the invention includes all modifications and enhancements within the scope and spirit of the following claims.